USC Dornsife
Dana and David Dornsife
College of Letters, Arts and Sciences
Spatial Sciences Institute

SSCI 684, Spatial Modeling with GIS

Syllabus

Units: 4

Term Day Time: Spring 2021 – Thursdays 2:00-4:50pm PT

Location: WPH 200

Instructor: Laura C Loyola, PhD
Office: AHF B55C
Regular Office Hours: Tues 11 am-12 pm and Wed 2-3 pm PT. Also available most days and times by appointment via email.
Contact Info: loyola@usc.edu, 213-740-5612

Library Help: Andy Rutkowski
Office: VKC 36B
Office Hours: Tue 10 am-12 pm and Thu 4:30-5:30 pm PT
Contact Info: arutkows@usc.edu, 213-740-6390
Zoom: Provided via Blackboard

IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: spatial_support@usc.edu, 213-821-4415

Course Scope and Purpose

This course explores how geographic information systems and related technologies (global positioning systems, remote sensing, etc.) can be used to promote and support the construction and simulation of dynamic models of coupled human-environment systems. The fundamental feature of such systems involves diffusion over time and space, and individual cases may range from diffusion of pollutants and invasive species across landscapes to the diffusion of disease by contact between individuals. The approaches used to model these phenomena may range from the continuous representation of system dynamics to the discrete interactions of individual elements of agent-based models. The measurement and modeling techniques used to describe spatial and temporal processes and patterns affecting human and environmental systems will be introduced with an assortment of weekly readings, discussions, and technical work. The course is aimed at doctoral students and a series of individual and group projects allow class participants to develop and use their own models for more detailed research. Calculus and programming experience may be helpful but are not required. In addition to the textbooks, exercises and readings will be provided from a variety of sources as required.

Learning Outcomes

On completion of this course, students will be able to:

- Describe the fundamental building blocks (data sources, data models, spatial analysis methods, programming tools, etc.) used in geographic information technologies and spatial models.
- Discuss how dynamic spatial models have been implemented to both simulate the functioning of coupled human-environment systems and understand their behavior under altered conditions.
- Explicate the ways in which advances in our knowledge of coupled human-environment systems on the one hand and computer technologies on the other hand have combined to allow more realistic and detailed representations of the spatiotemporal variability of these systems in spatial models.
- Discuss the impact of sampling, resolution, uncertainty, and error on spatial model outcomes and some of the new opportunities afforded by modern instrumentation and measurement techniques.
- Critically evaluate the types of models that will be required in the future to effectively manage land, water, air and biotic resources, assess environmental risks, and promote human health and well-being.

Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

Prerequisite(s): None

Co-Requisite(s): None
Concurrent Enrollment: Students must be enrolled in an existing USC PhD program
Recommended Preparation: Some GIS experience or permission of instructor

Class Conduct

Harassment, sexual misconduct, interpersonal violence, and stalking are not tolerated by the university. All faculty and most staff are considered Responsible Employees by the university and must forward all information they receive about these types of situations to the Title IX Coordinator. The Title IX Coordinator is responsible for assisting students with supportive accommodations, including academic accommodations, as well as investigating these incidents if the reporting student wants an investigation. The Title IX office is also responsible for coordinating supportive measures for transgender and nonbinary students such as faculty notifications, and more. If you need supportive accommodations you may contact the Title IX Coordinator directly (titleix@usc.edu or 213-821-8298) without sharing any personal information with me. If you would like to speak with a confidential counselor, Relationship and Sexual Violence Prevention Services (RSVP) provides 24/7 confidential support for students (213-740-9355 (WELL); press 0 after hours)

Course Structure

The course will be taught as a seminar and class meetings will be split between presentations and discussions of the assigned readings and any questions and related topics that arise from the readings. The learning and teaching strategies are student-centered. They aim to encourage a deep-learning approach by using reflection and self-evaluation. The course readings are designed to provide the essential background and framework for study. Students will be required to reflect on their learning through in-class discussions and a series of carefully crafted assignments.

Technological and Communication Requirements

Students are expected to have a working knowledge of GIS. The modeling software programs and geospatial data required for course assignments will be accessed using computing resources provided by the Spatial Sciences Institute.

SSI Server and Tech Support – At times this course utilizes the SSI Server which is a virtual desktop giving access to many different professional software. If you are unable to connect to the server or experience any type of technical issues, send an email using your USC account to SSI Tech Support at spatial_support@usc.edu, making sure to copy (cc) me on the email.

Required Readings

Students are expected to acquire the textbooks on their own, electronic versions are acceptable when available. Most journal articles are accessible through the USC Libraries system. If a student is unable to access the textbooks, please speak with the instructor at the start of the semester to establish a workaround.

1. Abar, Sameera, Georgios K. Theodoropoulos, Pierre Lemarinier, and Gregory M.P. O'Hare. 2017. "Agent Based Modelling and Simulation Tools: A Review of the State-of-Art Software." *Computer Science Review*. 24: 13-33.
2. Alexandrov, G.A., D. Ames, G. Bellocchi, M. Bruen, N. Crout, M. Erechtchoukova, A. Hildebrandt, F. Hoffman, C. Jackisch, P. Khaiter, G. Mannina, T. Matsunaga, S.T. Purucker, M. Rivington, L. Samaniego. 2011. "Technical Assessment and Evaluation of Environmental Models and Software: Letter to the Editor." *Environmental Modeling and Software.* 26: 328-336.
3. Bhaduri, B., E. Bright, P. Coleman, and M.L. Urban. 2007. "LandScan USA: A high resolution geospatial and temporal modeling approach for population distribution and dynamics." *GeoJournal.* 69, No. 1/2: 103-117.
4. Boulton, G., M. Rawlins, P. Vallance, and M. Walport. 2011. "Science as a Public Enterprise: The Case for Open Data." *The Lancet* 377, no. 9778 (May): 1633-1635.
5. Briggs, D. 2005. "The Role of GIS: Coping with Space (and Time) in Air Pollution Exposure Assessment." *Journal of Toxicology and Environmental Health A* 68: 1243-1261.
6. Brimicombe, Allen. 2010. *GIS, Environmental Modeling, and Engineering* 2nd ed. Boca Raton: CRC Press. (available at VKC and as an e-book form USC Libraries)
7. Brunsdon, Chris. 2008. "Inference and Spatial Data." In *The Handbook of Geographic Information Science,* edited by Wilson, John P. and A. Stewart Fotheringham, 337-351. Oxford: Blackwell Publishing.
8. Brunsdon, Chris, A. Stewart Fotheringham, and Martin E. Charlton. 1996. "Geographically Weighted Regression: A Method for Exploring Spatial Non-stationarity." *Geographical Analysis.* 28, no. 4 (October): 281-289.
9. Carrie, D.J., C. Smith, P. Jagals. 2018. "The Application of System Dynamic Modelling to Envirnomental Health Decision-Making and Policy – A Scoping Review. *BMC Public Health.* 18: 402.
10. Crooks, A., N. Melleson, E. Manley, and A. Heppenstall. 2019. *Agent-Based Modelling & Geographic Information Systems: A Practical Primer*. Los Angeles, CA: SAGE Publications, Ltd. (available as an e-book from Amazon, NOT available via USC Libraries)
11. de Vos, M.G., S.J.C. Janssen, L.G.J. van Bussel, J. Kromdijk, J. van Vliet, and J.L. Top. 2011. "Are Environmental Models Transparent and Reproducible Enough?" In *Proceedings of Nineteenth International Congress on Modeling and Simulation,* Perth, Australia: 2954-2961.
12. Daniel, C.J, B.M. Sleeter, L. Frid, and M-J Fortin. 2018. "Integrating Continuous Stocks and Flows into State-and-Transition Simulation Models of Landscape Change." *Methods in Ecology and Evolution*. 1-11.
13. Galea, S., C. Hall, and G. Kaplan. 2009. "Social Epidemiology & Complex System Dynamic Modelling as Applied to Health Behaviour & Drug Use Research". *International Journal of Drug Policy.* 20, no.3 (May): 209-216.
14. Gebbert, S. and E. Pebesma. 2014. A temporal GIS for Field Based Environmental Modeling." *Environmental Modelling & Software.* 53: 1-12

15. Graham, S.E. and T. McCurdy. 2004. “Developing Meaningful Cohorts for Human Exposure Models.” *Journal of Exposure Analysis and Environmental Epidemiology* 14: 23-43.
16. Gurram, S. A.L. Stuart, and A.R. Pinjari. 2019. “Agent-based Modeling to Estimate Exposures to Urban Air Pollution from Transportation: Exposure Disparities and Impacts of High-resolution Data.” *Computers, Environment and Urban Systems*. 75: 22-34
17. Halvorsen, R.S., S. Mazzoni, J.S. Dirksen, E. Naesset, T. Gobakken, and M. Ohlson. 2016. “How Important are Choice of Model Selection Method and Spatial Autocorrelation of Presence Data for Distribution Modelling by Maxent?” *Ecological Modelling*. 328:108-118
18. Hijmans, R.J. 2012. “Cross-validation of Species Distribution Models: Removing Spatial Sorting Bias and Calibration with a Null Model.” *Ecology*. 93 (no.3): 679-688. https://doi.og/10.1890/11-0826.1
19. Huang, Q., D.C. Parker, T. Filatova, and S. Sun. 2014. “A Review of Urban Residential Choice Models Using Agent-base Modeling.” *Environment and Planning B: Planning and Design.* 41: 661-689
20. Huang, Y-N, B.J. Reich, M. Fuentes, and A. Sankarasubramanian. 2019. “Complete Spatial Model Calibration.” *The Annals of Applied Statistics*. 13 (no.2): 746-766.
21. Jakeman, A.J., R.A. Letcher, and J.P. Norton. 2006. “Ten Iterative Steps in Development and Evaluation of Environmental Models.” *Environmental Modeling and Software.* 21, no. 5 (May): 602-614.
22. Jarvis, Claire H., and Neil Stuart. 2001a. “A Comparison Between Strategies for Interpolating Maximum and Minimum Daily Air Temperatures. Part I: The Selection of "Guiding" Topographic and Land Cover Variables.” *Journal of Applied Meteorology.* 40, no. 6 (June): 1060-1074.
23. Jarvis, Claire H., and Neil Stuart. 2001b. “A Comparison Between Strategies for Interpolating Maximum and Minimum Daily Air Temperatures. Part II: The Interaction Between Number of Guiding Variables and the Type of Interpolation Method.” *Journal of Applied Meteorology.* 40, no. 6 (June): 1075-1084.
24. Jiang, N. A. Crooks, W. Wang, and Y. Xie. 2021. “Simulating Urban Shrinkage in Detroit via Agent-based Modeling.” *Sustainability*. 13: 2283
25. Jones, K., D. Manley, R. Johnston, and D. Owen. 2018. “Modelling Residential Segregation as Uneveness and Clustering: A Multilevel Modelling Approach Incorporating Dependence and Tackling MAUP.” *Environment and Planning B: Urban Analytics and City Science.* 45(no.6): 1122-1141.
26. Kanarogloua, P.S., M. Jerrett, J. Morrison, B. Beckerman, A. Arain, N.L. Gilbert, and J.R. Brook. 2005. “Establishing an Air Pollution Monitoring Network for Intra-urban Population Exposure Assessment: A Location-Allocation Approach.” *Atmospheric Environment.* 39, no. 13 (April): 2399-2409.
27. Kauhl, B., J. Schweikart, T. Krafft, A. Keste, M. Moskwyn. 2016. “Do the Risk Factors for Type 2 Diabetes Mellitus Vary by Location? A Spatial Analysis of Health Insurance Claims

in Northeastern Germany Using Kernel Density Estimation & Geographically Weighted Regression." *International Journal of Health Geographies.* 15: 38.

28. Kwan, Mei-Po. 2018. "The Neighborhood Effect: Contextual Uncertainties in Geographic, Environmental Health, and Social Science Research." *Annals of the American Association of Geographers.* 108(no.6): 1482-1490.
29. Li, K. and N.S.N. Lam. 2018. "Geographically Weighted Elastic Net: A Variable-Selection and Modeling Method Under the Spatial Spatially Nonstationary Condition." *Annals of the American Association of Geographers.* 108(6): 1582-1600.
30. Li, K., R. Habra, H. Deng, R. Urman, J. Morrison, F.D. Gilliand, et al. 2019. "Applying Multivariate Segmentation Methods to Human Activity Recognition from Wearable Sensors' Data." *JMIR Mhealth Uhealth.* 7,no. 2 (Feb): e11201.
31. Lilburne, L. and S. Tarantola. 2009. "Sensitivity of Spatial Models." *International Journal of Geographic Information Science*. 23(no.2): 151-168.
32. Maglio, P., M.J. Sepulveda, and P.L. Mabry. 2014. "Mainstreaming Modeling and Simulation to Accelerate Public Health Innovation." *American Journal of Public Health*. 104(no 7): 1181-1186.
33. Mallalo, A., L. Mao, P. Rashidi, and G. E. Glass. 2019. "A GIS-Based Artificial Neural Network Model for Spatial Distribution of Tuberculosis Across the Continental United States." *Int. J. Environ. Res. Public Health.* 16:157.
34. Manyangadze, T., M.J. Chimbari, M. Gebreslasie, P. Ceccato, and S. Mukaratirwa. 2016. "Modelling the Spatial and Seasonal Distribution of Suitable Habitats of Schistosomiasis Intermediate Host Snails using Maxent in Ndumo Area, KwaZulu-Natal Province, South Africa." *Parasites & Vectors*. 9:572 doi:10.11861s13071-016-1834-5.
35. Marusek, L.C., C. Cockburn, P.K. Mills, and B.R. Ritz. 2006. "Control Selection and Pesticide Exposure Assessment via GIS in Prostate Cancer Studies." *American Journal of Preventative Medicine.* 30(2S): S109-S116.
36. Mennis, J. 2006. "Mapping the Results of Geographically Weighted Regression." *Cartographic Journal.* 43, no. 2 (July): 171-179.
37. Moore, D.K., M. Jerrett, W.J. Mack, and N. Künzli. 2007. "A Land Use Regression Model for Predicting Ambient Fine Particulate Matter Across Los Angeles, California." *Journal of Environmental Monitoring.* 9: 246-252.
38. Mustapha, K, W. Gilli, J-M Frayret, N. Lahrich, and E. Karimi. 2016. "Agent-Based Simulation Patient Model for Colon and Colorectal Cancer Care Trajectory." *Procedia Computer Science*. 100: 188-197.
39. Neuwirth, C., B. Hofer, and A. Peck. 2015. "Spatiotemporal Processes and Their Implementation in Spatial System Dynamics Models." *Journal of Spatial Science*. 60 (no.2): 277-288.
40. O'Sullivan, D and G. Perry. 2013. *Spatial Simulation: Exploring Pattern and Process.* Oxford: Wiley-Blackwell. (available as an e-book from USC Libraries)
41. Patterson, L., M. Urban, A. Myers, B. Bhaduri, E. Bright, and P. Coleman. 2007. "Assessing Spatial and Attribute Errors in Large National Datasets for Population

Distribution Models: A Case Study of Philadelphia County Schools." *GeoJournal.* 69, no. 1-2 (June): 93-102.

42. Phillips, S.J., R.P Anderson, and R.E. Schapire. 2006. "Maximum Entropy Modeling of Species Geographic Distributions." *Ecological Modeling.* 190 (3-4): 231-259.
43. Schmolke, A., P. Thorbek, P. Chapman, and V. Grimm. 2010a. "Ecological Models and Pesticide Risk Assessment: Current Modeling Practice." *Environmental Toxicology and Chemistry.* 29, no. 4 (April): 1006-1012.
44. Schmolke, A., P. Thorbek, D. L. DeAngelis, and V. Grimm. 2010b. "Ecological Models Supporting Environmental Decision Making: A Strategy for the Future." *Trends in Ecology and Evolution.* 25, no 8 (August): 479-486.
45. Stewart, K., J. Fan, and E. White. 2013. "Thinking About Space-Time Connections: Spatiotemporal Scheduling of Individual Activities." *Transactions in GIS.* 17, no.6: 791-807.
46. Taboada, M., E. Cabrera, F. Epelde, Ma L. Iglesia, and E. Luque. 2013. "Using Agent-Based Simulation for Predicting the Effects of Patients Derivation Policies in Emergency Departments." *Procedia Computer Science*. 18:641-650.
47. Thomson, D.R., D.A. Rhoda, A.J. Tatem, and M.C. Castro. 2020. "Gridded population survey sampling: a systematic scoping review of the field and strategic research agenda." *International Journal of Health Geography*. 19:34.
48. Thomson, D.R., F.R. Stevens, N.W. Ruktanonchai, A. Tatum, and M. Castro. 2017. "GridSample: An R-package to Generate Household Survey Primary Sampling Units (PSUs) from gridded Population Data." *International Journal of Health Geography.* 16:25.
49. Tracy, M., M. Cerdá, and K.M Keye. 2018. "Agent-Based Modeling in Public Health: Current Applications and Future Directions." *Annual Review of Public Health.* 38: 77-94.
50. van der Sluijs, J.P. 2002. "A Way Out of the Credibility Crisis of Models Used in Integrated Environmental Assessment." *Futures.* 34, no. 2 (March): 133-146.
51. Weisberg, M., 2007. "Who is a Modeler?" *Brit. J. Phil. Sci.* 58: 207-233
52. Wilson, J.P. and P.A. Burrough. 1999. "Dynamic Models, Geostatistics, and Fuzzy Classification: New Sneakers for a New Geography?" *Annals of the Association of American Geographers.* 89: 736-46.
53. Zellner, M.L., L.B. Lyons, C.J. Hoch, J. Weizeorick, C. Kunda, and D.C. Milz. 2012. "Modeling, Learning, and Planning Together: An Application of Participatory Agent-base Modeling to Environmental Planning." *URISA Journal.* 24(1): 77-92.
54. Zhai, X., A.G. Russell, P. Sampath, J.A. Mulholland, B-U Kim, Y. Kim, and D. D'Onofrio. 2016. "Calibrating R-LINE Model Results with Observational Data to Develop Annual Mobile Source Air Pollutant Fields at Fine Spatial Resolution: Application in Atlanta." *Atmospheric Environment*. 147: 446-457.

Supplemental Readings

Students may utilize any of the following readings as supplemental materials, as background if needed on a certain GIS-related concept or for further exploration of topics covered in

discussions. Many, though perhaps not all, are listed in the syllabus where they may support course material.

1. Buzzelli, M., J. Su, B. Ainslie, D. Steyn, M. Brauer, and T. Larson. 2006. "A GIS Spatiotemporal Model of Ambient Air Pollution Exposure." *Epidemiology.* 17: S112-S118.
2. Green, K., R.G. Congalton, and M. Tukam (2017). *Imagery and GIS: Best Practices for Extracting Information from Imagery.* Redlands, CA: Esri Press. (as needed for remote sensing background) (NOT available via USC Libraries)
3. Jaga, K., and C. Dharmani. 2005. "The Epidemiology of Pesticide Exposure and Cancer: A Review." *Reviews on Environmental Health* 20, no. 1 (January): 15-38. (optional)
4. Jerrett, M., A. Arain, P. Kanaroglou, B. Beckerman, D. Potoglou, T. Sahsuvaroglu, J. Morrison, and C. Giovis. 2005. "A Review and Evaluation of Intraurban Air Pollution Exposure Models." *Journal of Exposure Analysis and Environmental Epidemiology* 15: 185-204. (optional review)
5. Longley, P.A., M.F. Goodchild, D.J. Maguire, and D.W. Rhind. 2015. *Geographic Information Systems and Science*. 4th ed. New York, NY: John Wiley and Sons. (Selected chapters) (available from USC Libraries Grand Depository)
6. Martin, D.J. 2008. "Social Data." In *The Handbook of Geographic Information Science,* edited by Wilson, John P. and A. Stewart Fotheringham, 35-59. Oxford: Blackwell Publishing. (optional)
7. Skidmore, A., 1st ed. 2002. *Environmental Modeling with GIS and Remote Sensing.* London: Taylor and Francis. (Optional reading for modeling background) (hardcopy available at VKC)

Description and Assessment of Assignments

Students must participate in class discussion on a regular basis, prepare written assignments in the form of discussion boards and model reports, and complete technical exercises and presentations.

Class Participation (10%): A class participation grade for the semester will be assigned based upon how actively students engage in the course. Students will be required to read all material outlined for each week of the course, and be prepared to lead and participate in group discussions about the readings in class. Failure to attend or to be adequately prepared to discuss the readings will lead to the assignment of a lower grade for that week.

Conceptual Model (5%): At the start of the semester students will work up and present a conceptual model of their respective research. A discussion on conceptual models will precede this assignment and the conceptual model should be developed utilizing these concepts (yup) and readings. This assignment is designed to provide students the opportunity to holistically examine and model their research question and variables, an integral part of developing methodologies and workflows.

Modeling Exercises (40%): Throughout the semester students will complete four exercises that provide students the opportunity to utilize and reflect upon the technical aspects of various

modeling software. Students will implement the model design to health issues/projects of their own. These exercises will require independent background research of the models and/or modeling software and incorporate written reviews of supporting documentation. The modeling exercise may take some time to work through and deliverables will consist of final model outputs plus a write up of 5-6 pages.

In-Class Presentation (15%): Students will conduct a seminar on a topic determined in consultation with the instructor in the second half of the classes scheduled in Weeks 10 and 11. A one-page summary will be distributed in advance of the class itself and the topic may be an evaluation of a model or software (Caline, RePast, etc.), a complex systems subject (fractals, modifiable areal unit problems, neural networks, etc.) or some specific technique or application that is relevant but not otherwise covered in the course.

Final Project (30%): In the second half of the course, students will work on projects determined in consultation with the instructor. Students will construct a spatial model to address some geographically relevant health problem, or problem of their own choosing. The final report and class presentation will summarize insights from each phase of the modeling process as experienced in the problem context.

Grading Breakdown

Assessment	Number	Points Each	% of Grade
Class Participation			10
Conceptual Model	1	5	5
Modeling Exercises	4	10	40
In-Class Presentation	1	15	15
Final Project	1	30	30
Total	7	-	100

Assignment Submission Policy

Assignments will be submitted for grading via Blackboard using the due dates specified in the Course Schedule below. Students are expected to attend and participate in every class session and to complete and upload all assignments by the deadlines detailed in the Course Schedule. Late work will be assessed a penalty of 10% per day and zero grades will be assigned for work that is more than one week late.

Schedule

	Topic	Readings and Assignments	Deliverables/Due Dates
Module 1: Fundamentals of Spatial Models			
Week 1 1/10	**Introduction to Class** Brief introductions coupled with a discussion of class goals, projects, technology, reading assignments, and conceptual models.	Maglio et al (2014); Wilson & Burrough (1999); Crooks et al (2019) Forward, Ch1; Skidmore (2002) Ch 1 (optional, as needed)	No deliverables.
Week 2 1/18* *Monday, 1/17 is a university holiday	**Presentations and Discussion of Conceptual Models** **Why Use Models and Differentiating Spatial Models** Discuss the importance and value of modeling processes. We discuss what differentiates spatially explicit models and spatial modeling software.	O'Sullivan & Perry (2013) Ch. 1; Gebbert and Pebesma (2014); Stewart et al. (2013); Brimicombe (2010) Ch. 2; Longley et al (2015) Ch. 14, 15 (as needed); Skidmore (2002) Ch. 2 (as needed)	Conceptual Model
Week 3 1/24	**The Art of Modeling and Avoiding Bias in Models:** Discuss the various features of successful modeling applications, including the need for parsimony, transparency, patience, and the human element of modeling. How these elements can be captured and passed to the users and use cases; how to avoid model bias	Alexandrov et al. (2011); Jakeman et al. (2006); Schmolke et al. (2010a, b); O'Sullivan & Perry (2013) Ch. 3**;** de Vos et al. (2013); Weisberg (2007);	No deliverables.
Week 4 1/31	**Rethinking and Preparing Models in a GIS:** A discussion of the importance of and methods used to revise and process a variety of social and environmental datasets, and new data sources for use with a GIS and spatial models.	Crooks, et al. (2019) Ch. 9; Boulton et al. (2011); Bhaduri et al. (2007); Thomson et al (2017); Thomson et al (2020) Graham et al. (2004); Li et al (2019) Martin (2008) (optional) Green et al (2017) Ch. 3, 4, 7, and 9 (if unfamiliar with Remote Sensing)	Modeling Exercise #1

	Topic	Readings and Assignments	Deliverables/Due Dates
Module 2: Modeling Environmental Systems and Health			
Week 5 2/7	**Patterns and Processes:** A discussion of some of the ways forces of attraction and segregation, individual mobile entities, and processes of spread are featured in models of social and environmental systems.	O'Sullivan & Perry (2013) Ch. 2; Brimicombe (2010) Ch. 9; Jarvis & Stuart (2001a, b); Jones et al (2018); Briggs (2005); Buzzelli et al. (2006)	No deliverables.
Week 6 2/14	**Weighing the Influence of Variables:** A discussion of spatially explicit variables in distribution models (Maxent) and when spatially heterostatic (GWR)	Halverson et al (2016); Mennis (2006); Phillips et al (2006); Manyanngadze et al (2016); Kauhl et al (2016) Li (2018) Brunsdon et al. (1996) (if needed)	Modeling Exercise #2
Week 7 **2/21**	**Uncertainty and Error Propagation in Models:** A review of the importance of data quality and discussion of some of the inherent errors in data and the effects of uncertainty in model inputs	Brimicombe (2010) Ch. 8; Patterson et al. (2007); Kwan (2018)	No deliverables.
Week 8 2/28	**Model Calibration & Validation:** An introduction to the special challenges and issues that are confronted when using GIS tools to describe and model place-based exposures and the spatial distributions of phenomena of interest.	Lilburne and Tarantola (2009) O'Sullivan & Perry (2013) Ch. 7; Zhai et al (2016); Hijmas (2012); Huang (2019); Zhai et al (2016)	No deliverables.
Module 3: Modeling Social Systems			
Week 9 3/7	**Dynamic System Models:** A discussion of the various ways stocks accumulate and flows occur in time and the mathematical modeling protocols used for stocks (integrals) and flows (differentials). Introduction to System Dynamic models.	Hovmand et al (2020) Ch. 15; Neuwirth et al (2015); Daniel et al (2018); Currie et al (2018); Galea et al (2009) Nelson et al. (2017)	Modeling Exercise #3

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 10 3/21	**Agent-Based Models:** A discussion of some of the ways which agents have been used to represent mobile individuals in dynamic models of human and environmental systems, and how complex system dynamics may be agent/individual-based or differential equation-based or both.	Abar et al (2017) Crooks et al (2019) Ch. 2, 3, and 7; Tracy et al (2018); Taboada et al (2013); Mustapha et al (2012)	No deliverables.
Week 11 3/28	**ABM in GIS:** Incorporating ABM into GIS.	Crooks et al (2019) (selected chapters); Li (2020); Jiang et al (2019); Zellner et al (2012); Huang et al. (2014); Gurram et al. (2019)	Presentation summary
Module 4: Coupled Human-Environment Systems			
Week 12 4/4	**Presentations:** In-class presentations on model or software evaluation.		Presentation
Week 13 4/11	**Modeling the Built and Social Environments:** Discussion of the interactions of our dynamic built environment and social environment with health outcomes and various forms of exposure	Moore et al. (2007); Kanarogloua et al. (2005); Marusek et al. (2006); **Additional readings TBD**	
Module 4: Research Trends and the Future of Spatial Modeling			
Week 14 4/18	**Spatial and Computational Models:** Discuss the distinction between spatial and computational models and an introduction to how spatially explicit models can be transformed.	Mallalo et al. (2019); Crooks et al (2019) Ch. 12 **Additional readings TBD	Modeling Exercise #4
Week 15 4/25* Friday, 4/29 last day of classes	**Final Presentations:** Students will present their projects, summarizing the insights garnered from each phase of the modeling process as experienced in their specific problem context.		Final project presentations in class. Final report due by 5 p.m. on last day of classes 4/29
Final Exams	**Final Assessment Thursday, May 5 2:00-4:00pm PT**		

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on Research and Scholarship Misconduct.

Students and Disability Accommodations

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu

Support Systems

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
eeotix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
osas.usc.edu
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.
USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity, and Inclusion - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
ombuds.usc.edu
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

*Occupational Therapy Faculty Practice - (323) 442-33*40 or otfp@med.usc.edu
chan.usc.edu/otfp
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.